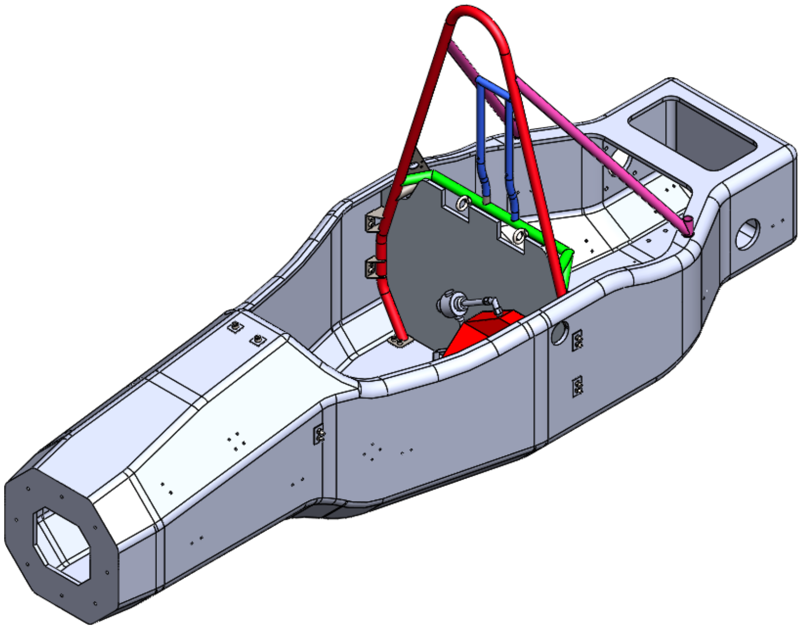
2023 Structural Equivalency Spreadsheet

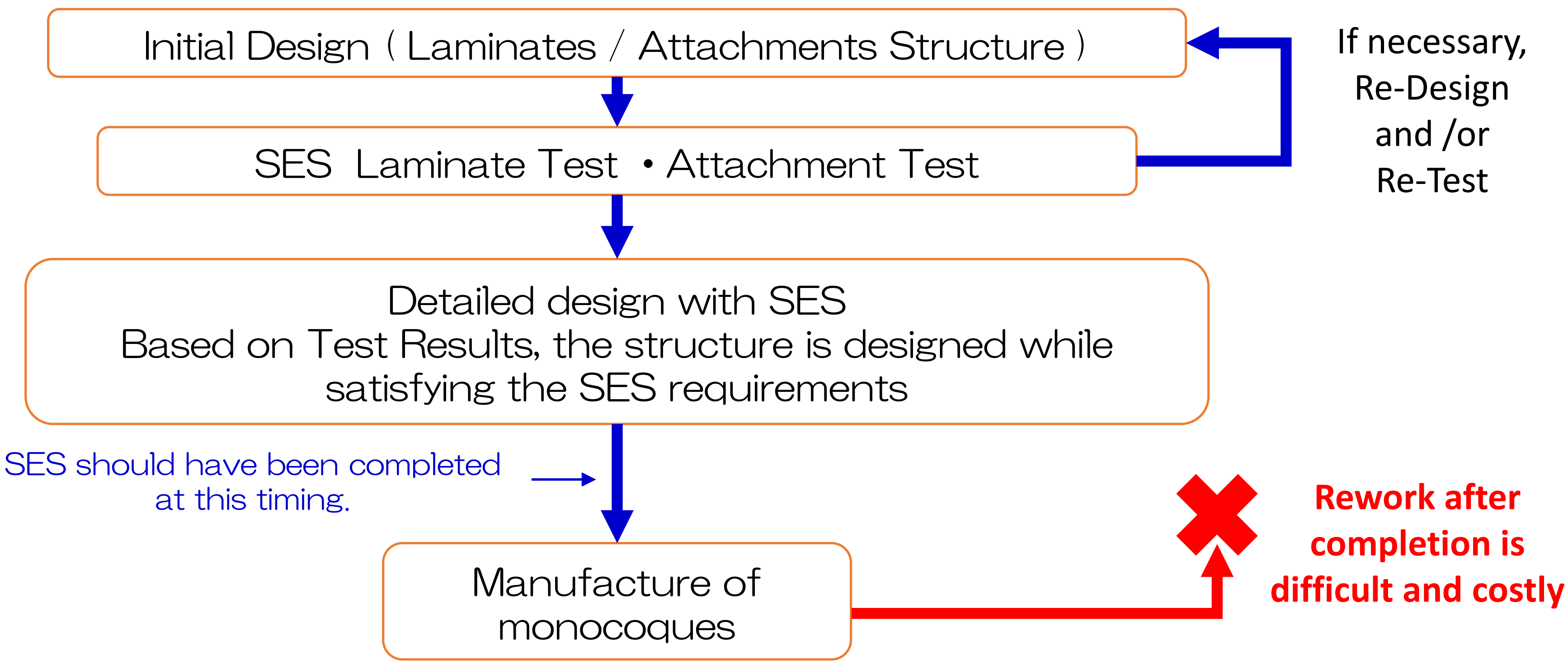
Monocoque



How to describe Monocoque SES

Dsign flow with SES

SES requires proof tests (Laminate Test and Attachment Test) for equivalence proof
⇒ By making good use of SES,
you can avoid the risk of fatal rework and non-compliance with rules.



If you test after manufacturing Monocoque and find that it lacks strength or does not comply with the rules,
Recovery is more difficult than Steel Tube Frame, so use SES well!

How to describe Monocoque SES

Basic Procedure of SES input

① F.3.1-5 Tube Chassis -> Basic Info & Select [Tube] or [Composite]
Define your Composite Portion in the Structure.

↓

② F.4.3 Composite
If necessary, duplicate [F.4.3 Composite] Sheet for Different or Additional Layup
It’s strongly recommended to be completed before proceeding to the next step.

↓

③ Test section in F.7.9-10 Attachments & in F.8 Front Protection (& in F.10-11 EV Accumulator)
Sometime test results affect your Chassis design

↓

④ F.7 Composite Chassis, Remaining F.7.9-10 Attachments (and F.10-11 EV Accumulator)

↓

⑤ Remaining F.8 Front Protection
Front Bulkhead section requires to complete FBHS section in F.7 Composite Chassis

↓

⑥ Fill in remaining BLANKs

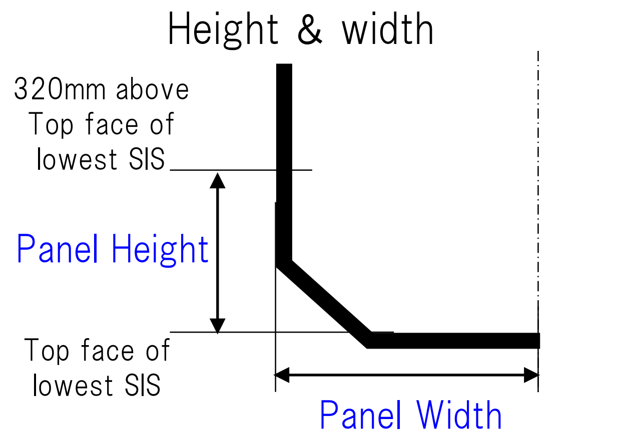
* Of course, BLANKs may be filled when possible.

Basic concept of Monocoque SES

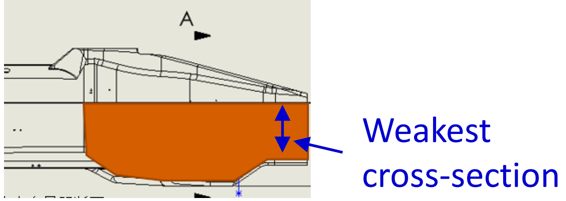
Basic Calculations of Monocoque

Monocoque Guidance Scenario 1 : Equivalent Flat Panel Calculation (F.4.4)

At the weakest cross-section of structure, the EI of the monocoque is calculated as the EI of a flat panel with the same composition as the monocoque about the neutral axis of the laminate. The curvature of the panel and geometric cross section of the monocoque must be ignored for these calculations. It stands for safer calculation.



e.g. Side impact structure



Note：Comply with F.4.4 for the following calculations

- Front Bulkhead Support Structure
  Vertical wall must have EI more than ONE Baseline steel tube.
- Side Impact Structure
  Vertical wall must have EI more than TWO Baseline steel tube
  Floor Panel must have EI more than ONE Baseline steel tube

see (F.7.3.2, F.7.5.3, F.7.5.4)

Note： They should be calculated about the weakest cross-section of structure.

2023 Structural Equivalency Spreadsheet

Monocoque

F.4.3 **Composite**

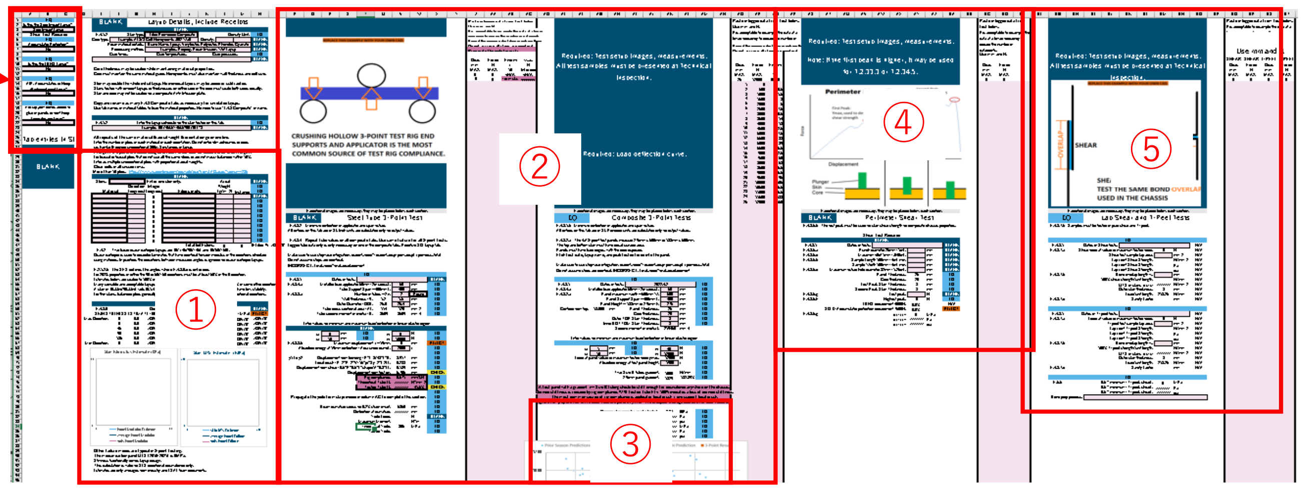
Monocoque Laminate Test

Derivation of Key Elements for Proof of Equivalence

If it is a tube frame, it is possible to use common values for physical properties such as Young's modulus and yield strength, but for Monocoque, physical properties vary greatly depending on how it is made, so it is essential to derive physical properties through actual tests.

Diversion of test results from different years is prohibited (F.4.3.1b).

Select usage of Laminate



①Quasi-Isotropic F.4.2, F4.3.6

②(only for SIS/Accumulator Side Protection) Equivalency Test (F.4.3.1-F.4.3.4)

③Derived physical property value for F.7

④(only for SIS/FBHS/Accumulator Protection) Shear strength F.4.3.5

⑤(if using adhesion) Shear & Peel strength of adhesion F.4.3.7

Monocoque Laminate Test

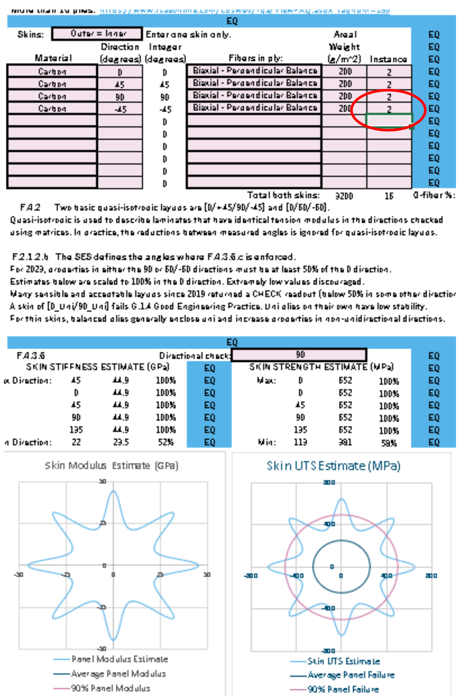
2023 revised

①Quasi-Isotropy

Securing quasi-isotropy has been tightened since 2023 SES.
Skin thickness in F.7 Composite Chassis has been changed from conventional actual thickness specification to scaling option

		Layup Used:	SIS F.4.3 Composite		EQ
			Monocoque		EQ
		Core thickness:	12	mm	EQ
Scaling option, layup repeats:	1	Outer skin thickness:	3	mm	EQ
Scaling option, layup repeats:	1	Inner skin thickness:	3	mm	EQ
		Panel thickness:	18	mm	EQ

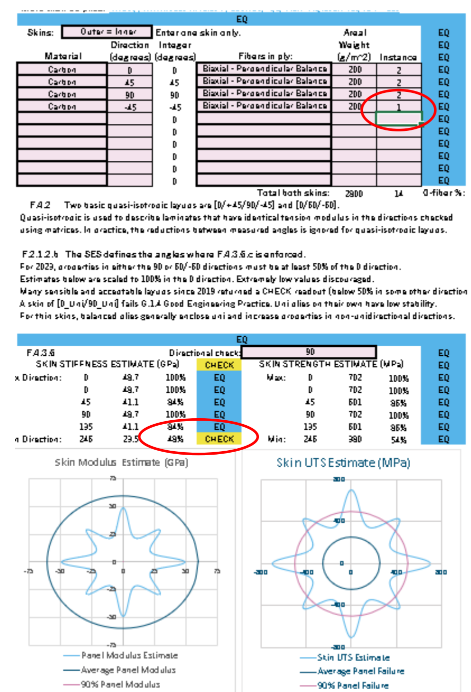
Must be an integral multiple of the Layup Schedule for Laminate Test
(Because thickness change of 1 ply unit may lose quasi-isotropy)



For example, if you subtract 1ply from [0/45/90/-45] evenly

Reduced stiffness in specific directions
⇒ Loss of quasi-isotropy

±60deg or 90deg direction need 50% or more at 0deg (See Comment in SES)



All thickness differences that are not integral multiples should be treated as Different Layups and their physical properties should be obtained using the Laminate Test.

Monocoque Laminate Test

②③ Equivalency Test & Laminate Test

② F.4.3.2- At the same time as proof of F.4.3.4, the specifications of ③ can be obtained

	BLANK			
F.4.3.1	Dates of tests:			BLANK
F.4.3.4.a	Metallic load applicator 50mm (2in radius):		mm	BLANK
	Tube Support Span =400mm L:		mm	BLANK
F.4.3.3.a	Number of tubes =2 n:		Round	BLANK
	Wall thickness (t):	1.2	mm	BLANK
	Outer Diameter (OD):	25.0	mm	BLANK
	Tube cross sectional area (A):	114	mm^2	BLANK
	Tube second moment of inertia (I):	8509	mm^4	BLANK

Enter values for minimum and maximum load/deflection in linear-elastic region

	BLANK					
x_1	mm	BLANK	y_1		N	BLANK
x_2	mm	BLANK	y_2		N	BLANK

F.4.3.3.b	Maximum displacement >=19mm:	0	mm	REJECT
	Absorbed energy at 19mm deflection (Area under curve):		J	BLANK
				EQ
y1 to y2	Displacement from bending (P*L^3/48*E*I):	#DIV/0!	mm	EQ
	Local crush (P^2*R^2*t/(16*pi*Sy^2*I^2)):	#DIV/0!	mm	EQ
	Displacement from shear (0.5*P*0.5*L*shape/A*0.3*E):	#DIV/0!	mm	EQ
	Displacement from test rig:	#DIV/0!	mm	#DIV/0!
	Rig compliance:	#DIV/0!	mm/kN	EQ
	Theoretical EI:	#VALUE!	N*mm^2	EQ
	Tested EI, uncorrected:			EQ
				EQ
	Propagate the yield formula provided in column AC to complete this section.			EQ
				EQ
	Beam curvature radius for 0.2% strain offset:	0	mm	EQ
	Deflection at curvature:	0.00E+00	mm	EQ
	Yield Force:		N	BLANK
	Maximum Moment:		N*m	EQ
	Theoretical Yield:	305	MPa	EQ
	Tested Yield:			EQ

Test results are valid for that year only
Historical data is invalid.

F.4.3.1 Testing Requirements

a. Any tested samples must be engraved with the construction date, sample name, and peak test force.

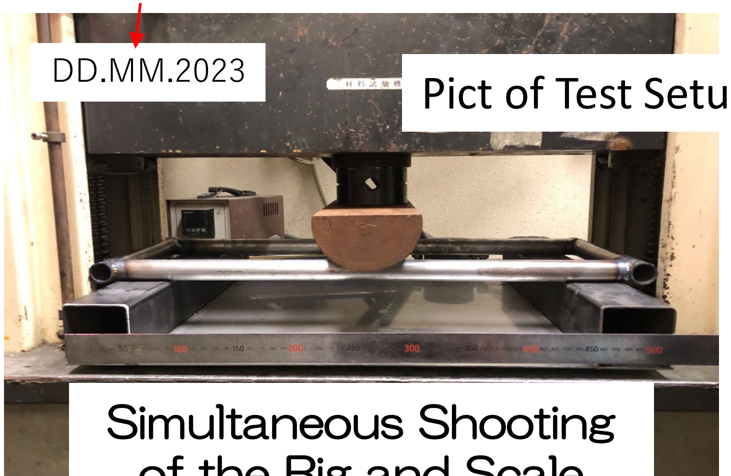
b. The same set of test results must not be used for different monocoques in different years.

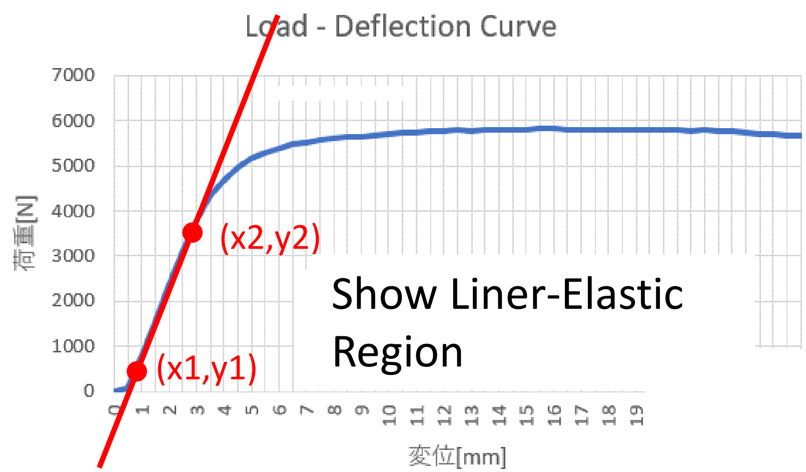
The intent is for the test panel to use the same material batch, material age, material storage, and student layup quality as the monocoque.

Explained on the next page

Monocoque Laminate Test

Take a photo with the date in the photo





Z	AA	AB	AC
Paste in logged data from test below:			
Use mm and N.			
It is acceptable to resample the data at a lowe			
frequency to reduce the number of datapoints.			
Repeat the energy calculation in column three.			
Do not assume all steps are identical.			
Propagate the yield formula.			
Disp.	Force	Energy	Yield
mm	N	J	N
MAX	MAX	10	Intercept
25	5820	98.21	5.52E+03
0	0	Formula:	-4.73E+03
0.5	80	0.04	-4.06E+03
1	810	0.445	-4.04E+03
1.5	1610	1.25	-4.09E+03
2	2350	2.425	-4.08E+03
2.5	3130	3.99	-4.11E+03
3	3830	5.905	-4.06E+03
3.5	4330	8.07	-3.81E+03
4	4680	10.41	-3.41E+03
4.5	4980	12.9	-2.96E+03
5	5160	15.48	-2.39E+03
5.5	5300	18.13	-1.78E+03
6	5400	20.83	-1.13E+03
6.5	5470	23.565	-4.46E+02
7	5520	26.325	2.54E+02
7.5	5570	[illegible]	[illegible]
[illegible]	[illegible]	80.815	1.42E+04
17	5800	83.715	1.50E+04
17.5	5810	86.62	1.57E+04
18	5800	89.52	1.65E+04
18.5	5790	92.415	1.72E+04
19	5790	95.31	1.80E+04
19.5	5800	98.21	1.87E+04
20	5800	[illegible]	[illegible]
20.5			

X1,y1

X2,y2

Yield column applies this formula to all rows

The Energy column is Integrated value (described later)

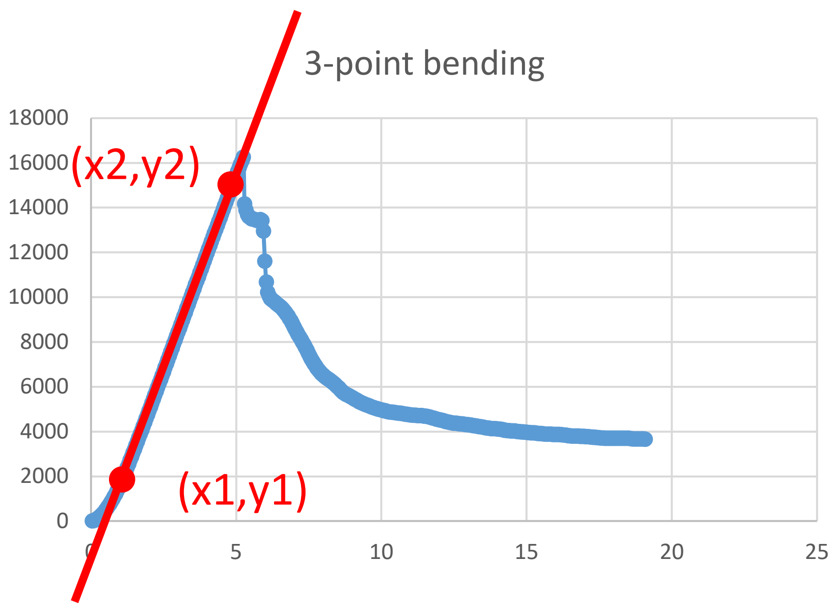
Raw Data must be input directly

Monocoque Laminate Test

Take a photo with the date in the photo

Simultaneous Shooting of the Rig and Scale

Test with the same Rig as the Steel Tube Test! (F.4.3.4)



Paste in logged data from test below:
Use mm and N.
It is acceptable to resample the data at
a lower frequency to reduce the number
Repeat the energy calculation in column t
Do not assume all steps are identical.

Disp.	Force	Energy
mm	N	J
MAX	MAX	19
21.5	14510	125.71
0	8	
0.5	203	0.1015
1	454	0.3285
1.5	705	0.681
2	980	1.171
2.5	1223	1.7825
3	1506	2.5355
3.5	1781	3.426
4	2040	4.446
4.5	2323	5.6075
5	2638	6.9265
5.5	2977	8.415
6	3340	10.085
6.5	3743	11.9565
7	4106	14.0095
7.5	4445	16.232
16.5	11187	88.2535
17	11566	94.0365
17.5	11921	99.997
18	12300	106.147
18.5	12655	112.475
19	13058	119.004
19.5	13405	125.706
20	13768	132.59
21	**14155**	139.668
21	14510	146.923
21.5	0	146.923

The Energy column is Integrated value (described later)

Raw Data must be input directly

Monocoque Laminate Test

Precautions when entering test data

Some items reflect the experimental RAW data attached, so the values of "Displacement", "Force", and "Energy" must all be entered directly.

Enter values for minimum and maximum load/deflection in linear-elastic region

			EQ				
x_1	0.5	mm	EQ	y_1	203	N	EQ
x_2	20	mm	EQ	y_2	13768	N	EQ
Force at panel failure or maximum tested force ymax:					14510	N	EQ
Absorbed energy at test panel height:						J	N/A
							EQ
Two Size B tubes gradient:					1500	N/mm	EQ
275mm panel gradient:					696	46.38%	EQ

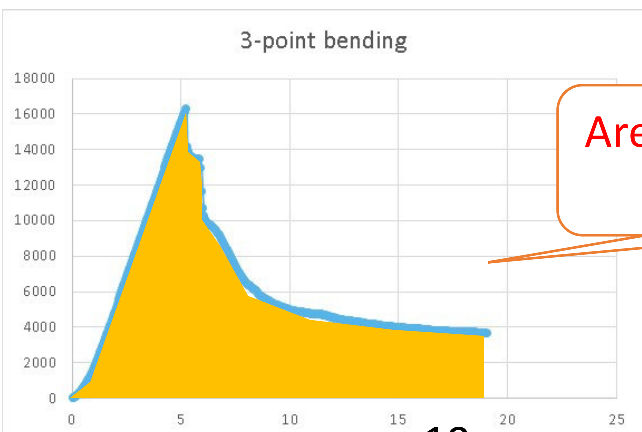
Paste in logged data from test below:
Use mm and N.
It is acceptable to resample the data at
a lower frequency to reduce the number
Repeat the energy calculation in column t
Do not assume all steps are identical.

Disp.	Force	Energy
mm	N	J
MAX	MAX	19
21.5	14510	125.71
0	8	
0.5	203	0.1015
1	454	0.3285
1.5	705	0.681
2	980	1.171
2.5	1223	1.7825
3	1506	2.5355
3.5	1781	3.426
16	10792	82.66
16.5	11187	88.2535
17	11566	94.0365
17.5	11921	99.997
18	12300	106.147
18.5	12655	112.475
19	13058	119.004
19.5	13405	125.706
20	13768	132.59
21	14155	139.668
21	14510	146.923
21.5	0	146.923

The Energy column should be entered as the cumulative Energy as shown in the formula below.

Energy(n) = Energy(n-1)+(Disp(n)-Disp(n-1))*Force(n)/1000

Correctly understand the meaning of Absorbed Energy!



19mm

Area of Deflection Curve
= Absorbed Energy

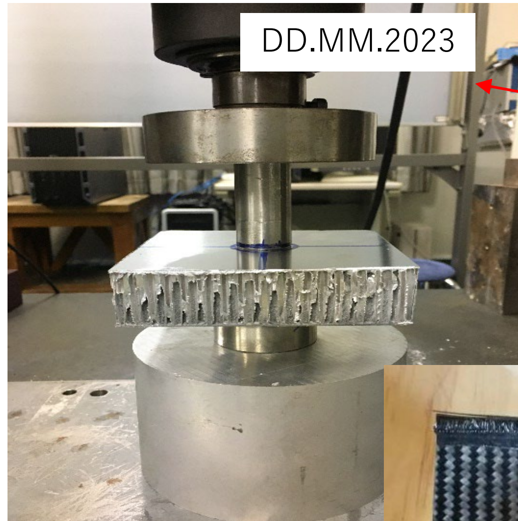
Monocoque Laminate Test

④Perimetr Shear test

Required: Test setup images, measurements.

Note: If the first peak is higher, it may be used for T.2.33.3 or T.2.34.5.

Required: Load deflection curve.



Take a photo with the date in the photo

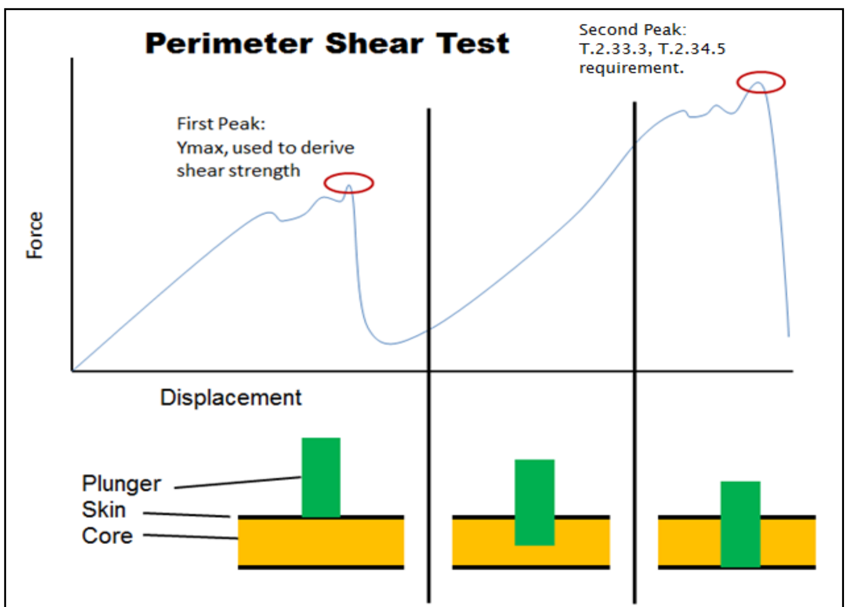
Paste in logged data from test below:

It is acceptable to resample the data at a lower frequency to reduce the number of datapoints.

Use mm and N.

Disp.	Force
mm	N
MAX	MAX
0	0

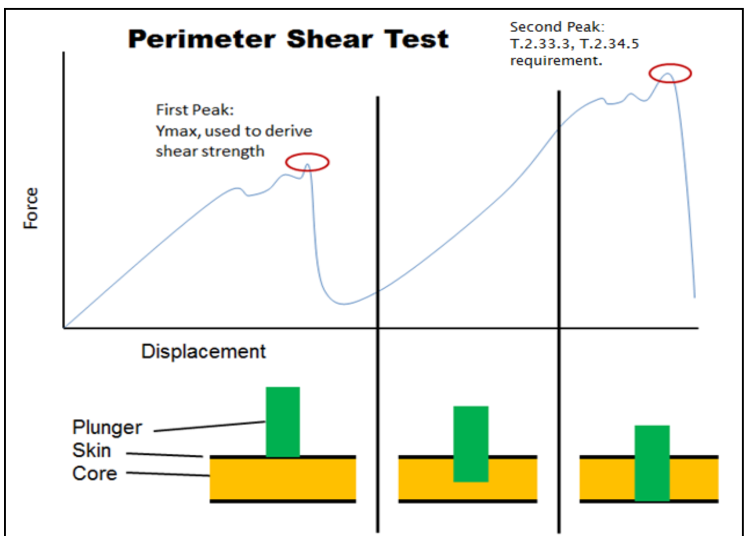
Raw Data must be input directly



Monocoque Laminate Test

Some items reflect the experimental RAW data attached, so the values of "Displacement " and "Force " must all be entered directly.

EQ				
F.4.3.1	Dates of tests:			N/A
F.4.3.5.a	Punch diameter 25mm (1in):		mm	N/A
F.4.3.5.e	Maximim fillet 1mm (.040in):		mm	N/A
F.4.3.5.b	Sample Length 100mm (4in) min:		mm	N/A
	Sample Width 100mm (4in) min:		mm	N/A
F.4.3.5.c	Maximum fixture hole diameter 32mm (1.25in):		mm	N/A
	Panel Thickness:	0	mm	N/A
	Core thickness:	0	mm	N/A
	First Peak Skin Thickness:	0	mm	N/A
	Second Peak Skin Thickness:	0	mm	N/A
F.4.3.5.g	First peak:		N	N/A
F.4.3.5.h	Highest peak:	0	N	N/A
	FBHS requirement 4000N:	0.0%		N/A
	SIS & Accumulator protection requirement 7500N:	0.0%		N/A
F.4.3.5.g	σ_{shear}:	0	MPa	

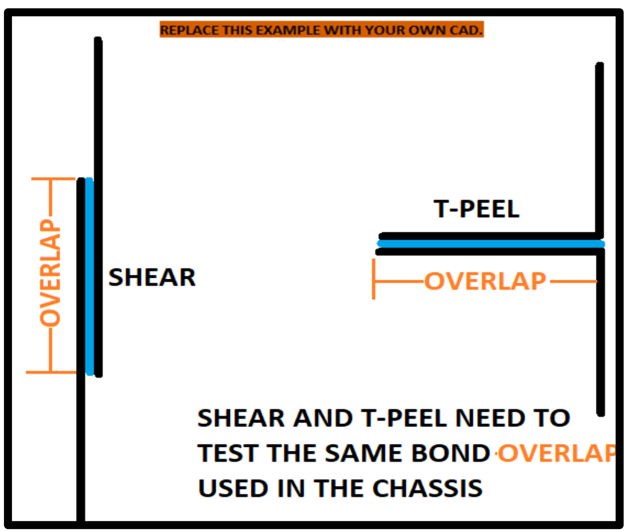


Disp. mm	Force N
MAX 12	MAX 13728.6
0	3.125
0.1	102.625
0.2	224
0.3	348.5
0.4	448
0.5	556.875
0.6	628.25
0.7	699.625
0.8	749.125
0.9	814.25
1	876.25
7	12652.5
7.1	12939.5
7.2	13210.88
7.3	13463.5
7.4	13728.63
7.5	3425
7.6	3521.875
7.7	3515.625

Monocoque Laminate Test

⑤ Lap-Joint Test

Enter test results for both Shear Test and T-Peel Test



	EQ			
F.4.3.1	Dates of Shear tests:			N/A
F.4.3.7.a	Shear force at failure or maximum tested force:	0	N	N/A
	Shear test sample lap area:		mm^2	N/A
	Lap Joint Shear Strength:		N/mm^2	N/A
	Lap Joint Shear Strength:		Pa	N/A
	Lap Joint Shear Strength:		psi	N/A
F.4.3.7.b	Bond overlap length w:		mm	N/A
	100% shear strength/unit length:		N/mm	N/A
	UTS of skins σ_{UTS}:	#DIV/0!	N/mm^2	N/A
	Outer skin thickness:	0	mm	N/A
	Load/unit length:	#DIV/0!	N/mm	N/A
F.4.3.7.d	Safety Factor		mm	N/A

	EQ			
F.4.3.1	Dates of T-peel tests:			N/A
F.4.3.7.a	Force at failure or maximum tested force:	0	N	N/A
	T-peel test sample lap area:		mm^2	N/A
	Lap Joint T-peel Strength:		N/mm^2	N/A
	Lap Joint T-peel Strength:		Pa	N/A
	Lap Joint T-peel Strength:		psi	N/A
F.4.3.7.b	Bond overlap length w:		mm	N/A
	100% T-peel strength/unit length:		N/mm	N/A
	UTS of skins σ_{UTS}:	#DIV/0!	N/mm^2	N/A
	Outer skin thickness:	0	mm	N/A
	Load/unit length:	#DIV/0!	N/mm	N/A
F.4.3.7.d	Safety Factor		mm	N/A

	EQ		
F.5.5	0.5 * minimum (T-peel, shear):	0	MPa
	0.5 * minimum (T-peel, shear):	#######	Pa
	0.5 * minimum (T-peel, shear):	#######	psi
	Bond prep process:		

Enter pretreatment for adhesion in 「Bond prep Process」
(e.g. polishing / degreasing)

Monocoque Laminate Test

A. Different or Additional Layup

If there are multiple types of layups, duplicate the SES F.4.3 Composite sheet and enter the test results each time

How to refer

F.7 Composite Chassis

Enter each sheet name in A4:B20 and select from the pull-down menu of each [Layup Used:]

Material	E (Pa)	S_Ultimate (Pa)	Shear (Pa)	Tested Core	Tested Outer	Tested Inner
	Note: Forces are given in Pa, not Mpa or Gpa.					
F.3.4.2 Steel	2.00E+11	3.65E+08	2.11E+08	mm	mm	mm
SIS F.4.3 Composite	8.07E+09	7.11E+07	0.00E+00	20	3	3
MHBS F.4.3 Composit	3.34E+10	1.78E+08	3.13E+07	15	2	2

REJECT			
F.7.4	Front Bulkhead Support Construction:	Composite	EQ
	Size C Steel Tubes Replaced On One Side:	3	EQ
	Layup Used:	MHBS F.4.3	EQ
		SIS F.4.3 Composite	EQ
	Core thickness:	MHBS F.4.3 Composite	EQ
Scaling option, layup repeats:	Outer skin thickness:		EQ
Scaling option, layup repeats:	Inner skin thickness:		EQ
	Panel thickness:		EQ
	Side View Height (Minus holes and single skins):		EQ

F.7.9-10 Attachments / F.8 Front Protection

Enter the sheet name directly in each [Type SES Tab Name Of Layup Used]

EQ				
F.7.5	Front Hoop Mounts:	Composite		EQ
	Front Hoop Mounts:	Bolted		EQ
Skin used: Both	Type SES Tab Name Of Layup Used:	MHBS F.4.3 Composite		N/A
	Front Hoop centerline length:	1000	mm	N/A
Scaling option, layup repeats: 2	Laminate thickness:	8	mm	N/A
	Skin shear area - centerline x 1 thickness:	0.008	m^2	N/A
	Skin shear strength:	3.13E+07	Pa	N/A

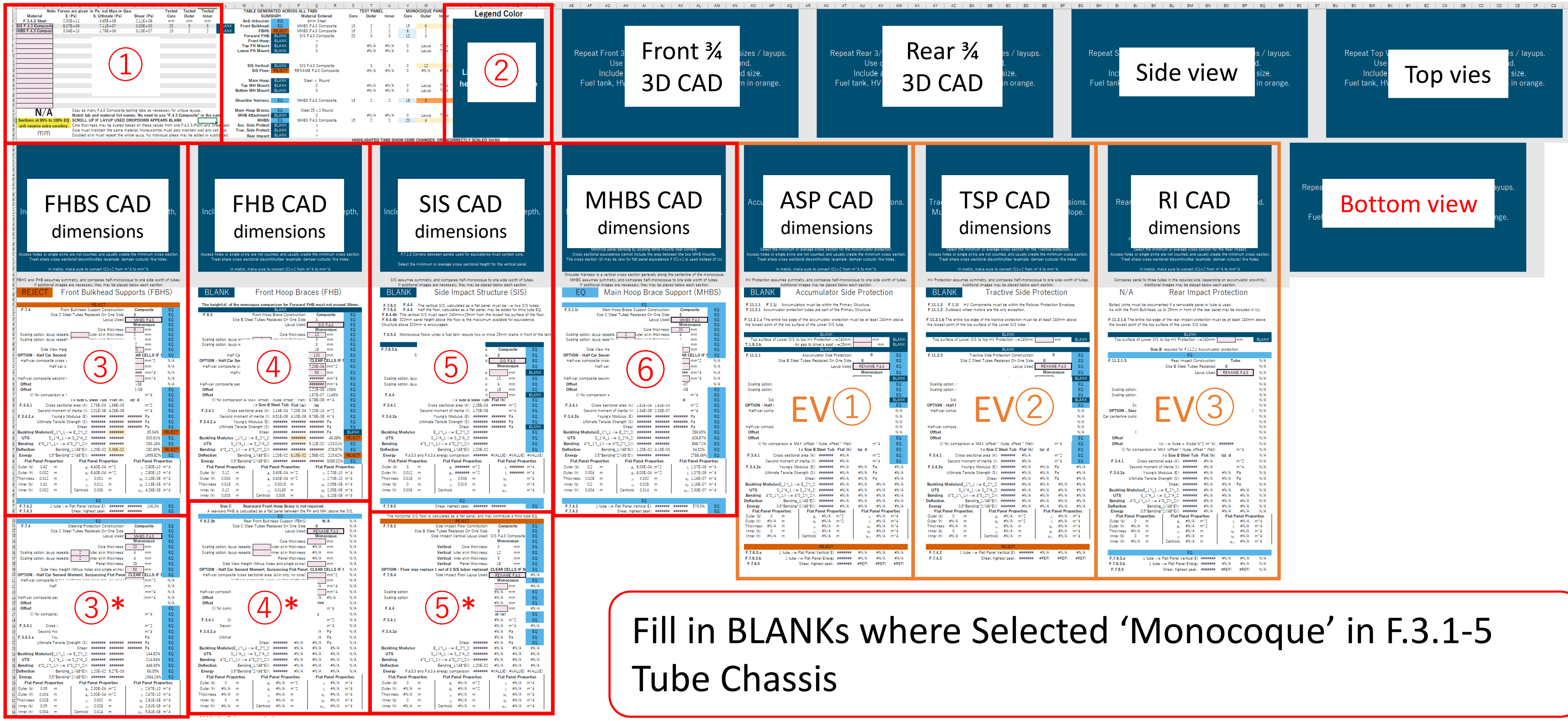
2023 Structural Equivalency Spreadsheet

Monocoque

F.7 **Composite Chassis**

F.7 Composite Chassis

Summary of F.7 Composite Chassis sheet



Fill in BLANKs where Selected 'Monocoque' in F.3.1-5 Tube Chassis

① Physical property value for each Layup (Enter F.4.3 Composite sheet name)

② Describe the color coding and meaning of colors for each layout of each figure

③ FHBS Equivalency (③* stands for Steering Protection)

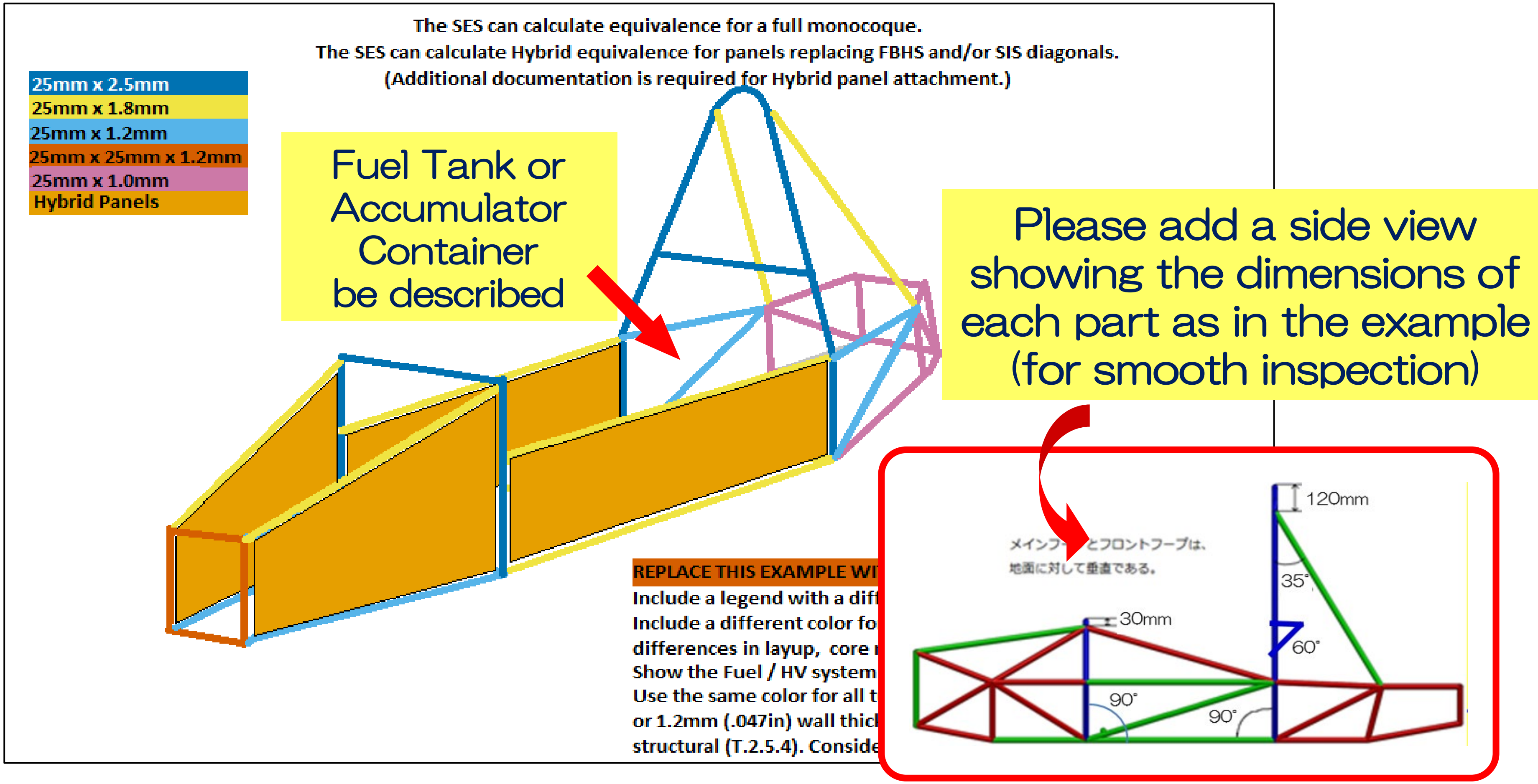
④ FHB Equivalency (④* stands for Rearward FHB if necessary)

⑤ SIS Equivalency (⑤* stands for the case of laminated floor)

EV①-③ EV Protection structure Equivalency.

F.7 Composite Chassis

Entry example of ¾ CAD



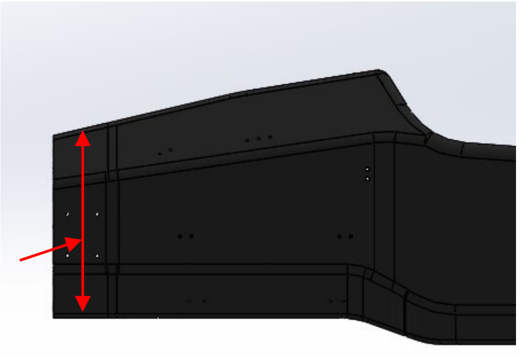
1. Show the requested CAD
2. Fuel Tank or Accumulator Container be described
3. It is recommended that the color coding of the pipe is the same as the sample.
4. All pipes with an outer diameter of <25 mm or a wall thickness of <1.2 mm Should be of the same color.

Front Bulkhead Supports (FBHS)

(1) Flat panel calculation

⇒ Based on Side view height, it will be evaluated as equivalent to 3 Size C steel tubes.
Indicate that the entered Panel Height is the weakest dimension
(If there is an opening, subtract its dimension)

Side View Height at
Weakest points

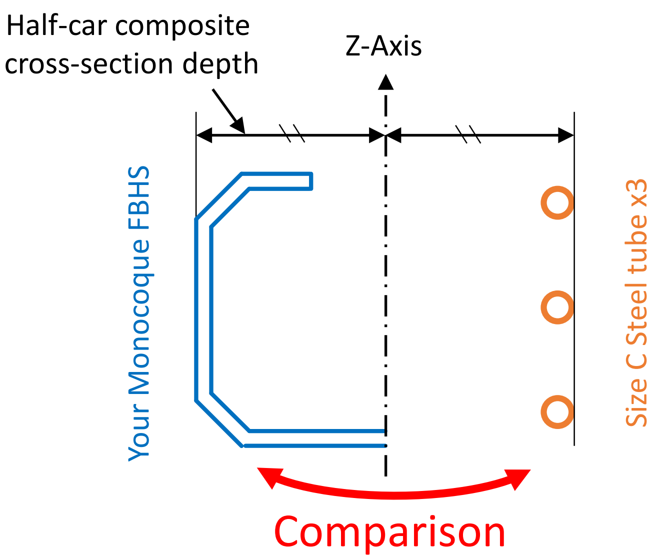


(2) If equivalence is less than 100% in (1), use OPTION - Half Car ~

Enter the Cross-sectional area of **skin only** to "Half-car composite cross sectional area"

Enter the Outer Width from car center axis to "Half-car composite cross-section depth" (refer to right fig.)

Enter the area moment of inertia Izz for **only the skin** around the vehicle center axis (Z axis) to "Half-car composite second moment about car centerline"

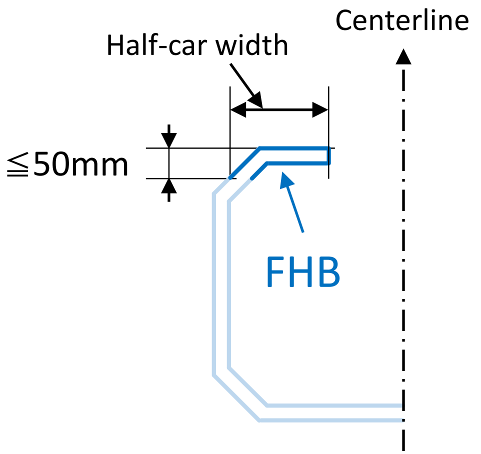


Front Hoop Braces (FHB)

(1) Flat panel calculation

⇒Based Half-car width, it will be evaluated as equivalent to Size B steel tubes.

Indicate that the entered Panel Width is the weakest dimension (If there is an opening, subtract its dimension)



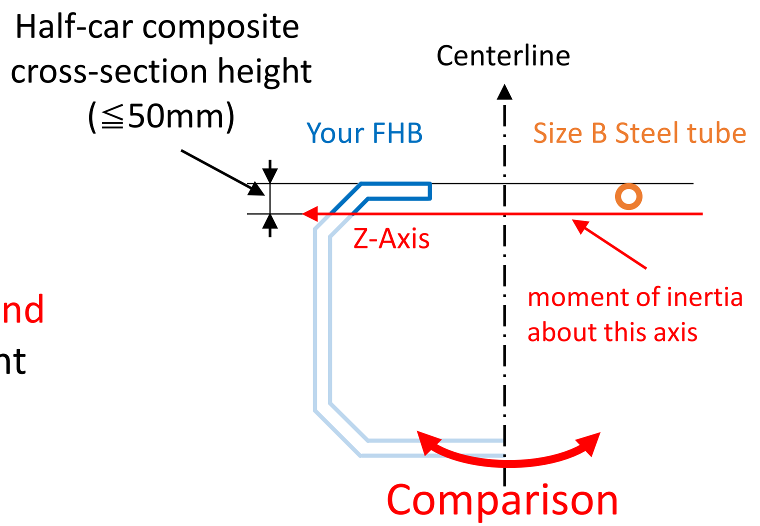
(2) If equivalence is less than 100% in (1), use OPTION - Half Car ~

Note that there is an error in the wording of the reference axis in SES

Enter the Cross-sectional area of **skin only** to "Half-car composite cross sectional area"

Enter FBH height from top (≦ 50mm) to "Half-car composite cross-section height"

Enter the area moment of inertia Izz for **only the skin** around **Z axis in right figure** to "Half-car composite second moment about car centerline"



Side Impact Structure (SIS)

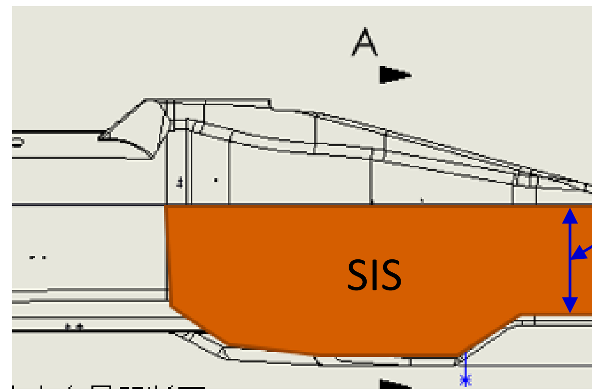
(1) Flat panel calculation

Unlike other areas of the monocoque, no allowance for geometric form is allowed.

Based on Side view Height & Half floor width, they will be evaluated as equivalent

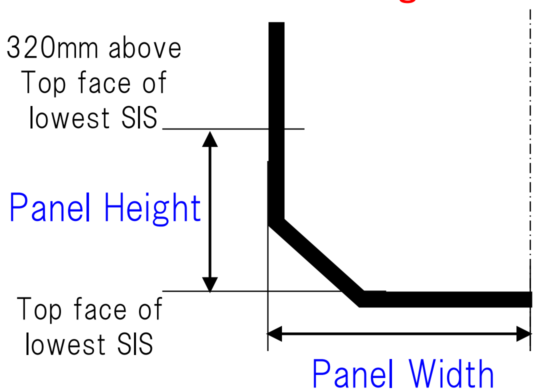
- Vertical Wall vs Size B Steel tube x2
- Horizontal Wall vs Size B Steel tube x1

(If there is an opening, subtract its dimension)



Side View Height at Weakest points

Geometric form is ignored



Side impact structure

SIS is the most important Driver Protection next to Roll Hoop among Primary Structures, so be sure to prove equivalence based on Rules!

Main Hoop Brace Support (MHBS)

(1) Flat panel calculation

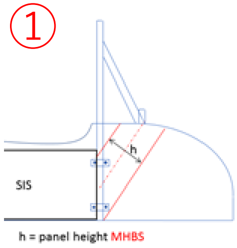
⇒ Based on Side view height, it will be evaluated as equivalent to 2 Size C steel tubes.
Indicate that the entered Panel Height is the weakest dimension
(If there is an opening, subtract its dimension)

Usually use the dimension h of ①

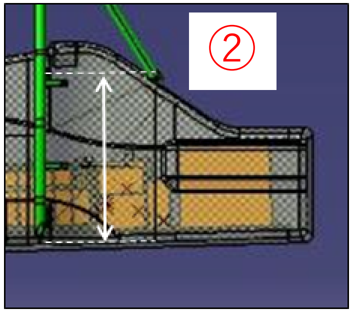
Monocoque that extend below the MHB to flat floor may use Panel Height of ②

③ refer to (2) OPTION calculation

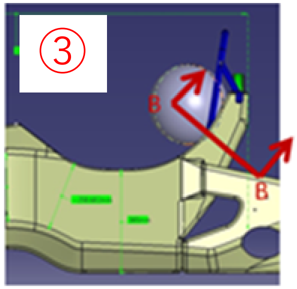
①



Ideally, monocoques orient their strength from midway between the MH mounts to the MHB.



Monocoques that extend below the MHB to a flat floor may use this flat panel height.



Monocoques with a limited path must use the minimum section, and are strongly encouraged to monitor laminate directional strength.

(2) If equivalence is less than 100% in (1), use OPTION - Half Car ~

Same as FBHS

Accumulator Side Protection
Tractive Side Protection
Rear Impact Protection

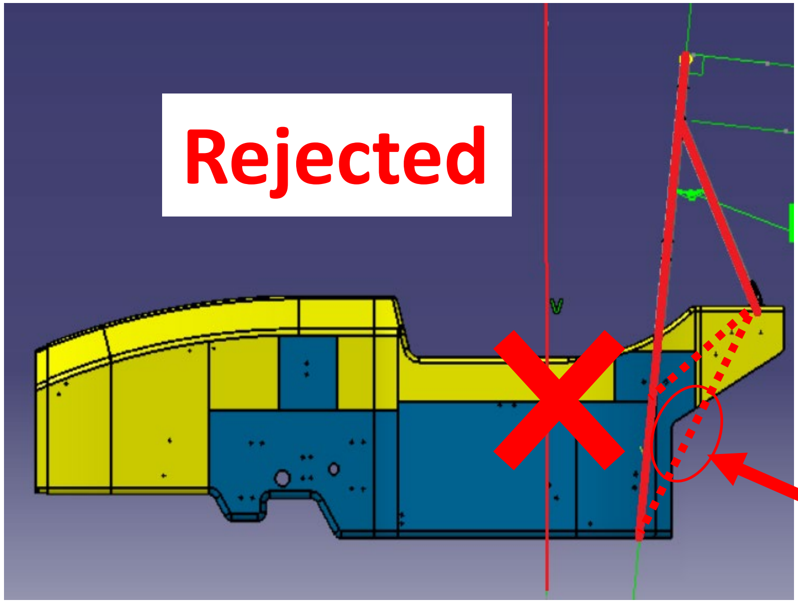
(1) Flat panel calculation

⇒ Based on input dimension, it will be evaluated as equivalent steel tubes.
Indicate that the entered dimension is the weakest.
(If there is an opening, subtract its dimension)

(2) If equivalence is less than 100% in (1), use OPTION - Half Car ~

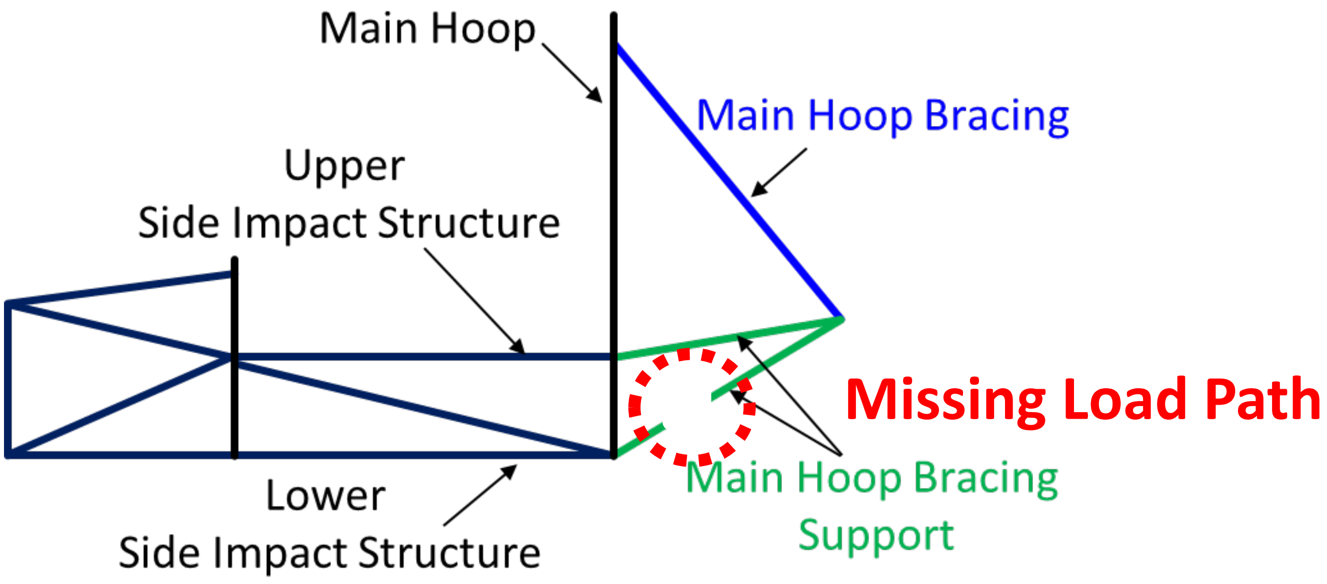
Same as FBHS

Rejected Sample

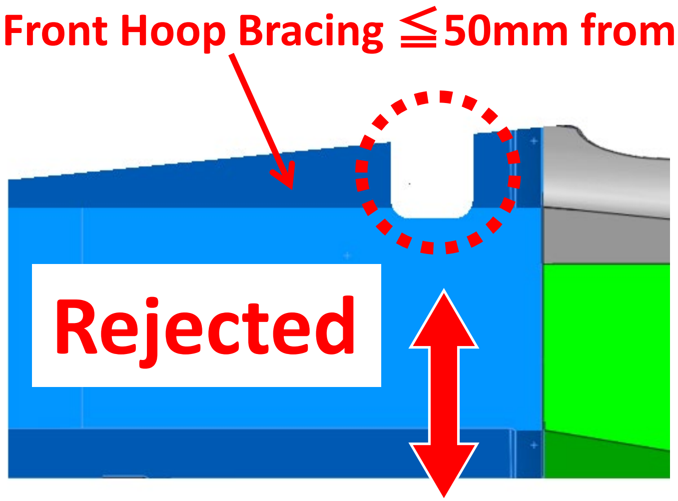


As shown in the CAD drawing, if there is a Missing at the connection of the Lower Main Hoop Bracing Support and the Lower Side Impact Structure, it is not recognized the Load Path

Composite material is insufficient.

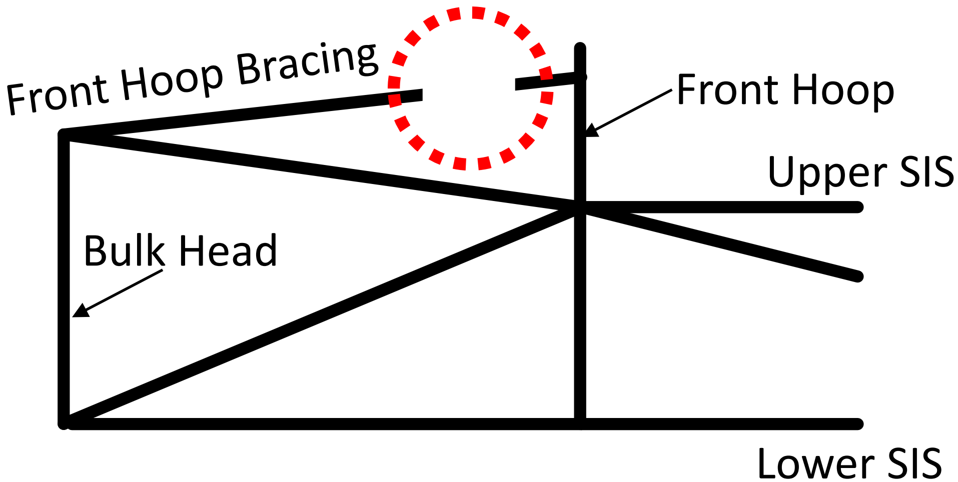


Rejected Sample



As shown in the CAD drawing above, if the part corresponding to the Front Hoop Bracing of the Mnocoque structure is cut to fix the damper, it will be rejected because it is considered that the FHB has been cut.

Front Hoop Bracing is Broken...

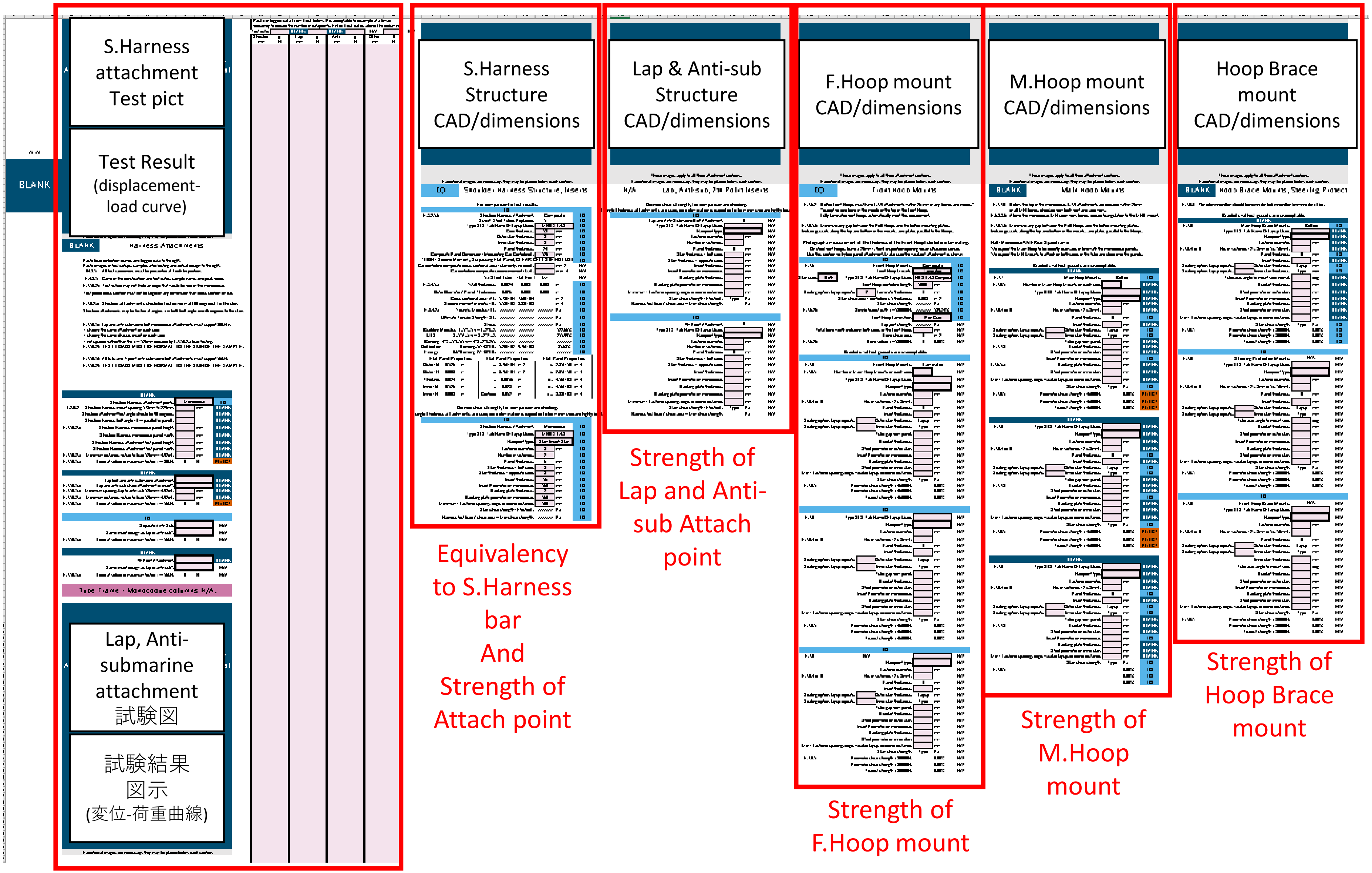


2023 Structural Equivalency Spreadsheet

Monocoque

F.10-11 **Attachments**

F.10-11 Attachments



Actual Test section Of Harness Attachments

Equivalency to S.Harness bar And Strength of Attach point

Strength of Lap and Anti-sub Attach point

Strength of F.Hoop mount

Strength of M.Hoop mount

Strength of Hoop Brace mount

Select Structure and fill in BLANKs

Harness Attachments

2023 revised

Load Deflection Curves
Test Setups and Measurement Pictures
Samples After Testing
Actual Design Images

	BLANK			
	Shoulder Harness attachment points:			BLANK
T.2.6.2	Shoulder harness mount spacing 178mm to 229mm:		mm	BLANK
	Shoulder attachment test angle should be 90 degrees:			BLANK
	Shoulder harness belt angle (0 = parallel to panel):			BLANK
F.7.10.2.c	Shoulder Harness monocoque panel height:		mm	BLANK
	Shoulder Harness monocoque panel width:		mm	BLANK
	Shoulder Harness attachment test panel height:		mm	BLANK
	Shoulder Harness attachment test panel width:		mm	BLANK
F.7.10.2.a	Minimum distance, fixture to load 125mm (4.92in):		mm	BLANK
F.7.10.1.a	Force at failure or maximum tested >= 30kN:	0	N	REJECT

	BLANK			
	Lap belt and anti-submarine attachment:			BLANK
F.7.10.1.d	Lap and anti-sub share attachment or insert?:			BLANK
F.7.10.1.d	Minimum spacing, lap to anti-sub 125mm (4.92in):		mm	BLANK
F.7.10.2.a	Minimum distance, fixture to load 125mm (4.92in):		mm	BLANK
F.7.10.1.c	Force at failure or maximum tested >= 15kN:	0	N	REJECT

	EQ			
	Separate Anti-Sub:			N/A
	Same insert design as lap or anti-sub?:			N/A
F.7.10.1.c	Force at failure or maximum tested >= 15kN:	0	N	N/A

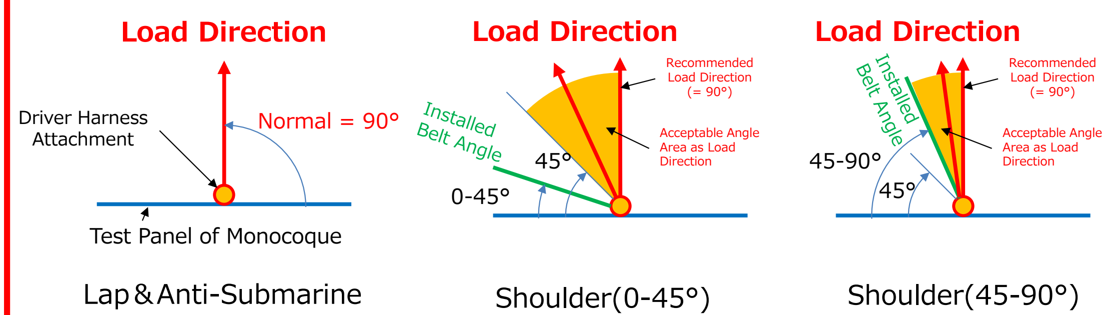
	BLANK			
	7th Point Attachment:			BLANK
	Same insert design as lap or anti-sub?:			N/A
F.7.10.1.c	Force at failure or maximum tested >= 15kN:	0	N	N/A

Paste in logged data from test below. It is acceptable to resample at a lower frequency to reduce the number of datapoints. **Enter test dates above the columns.**

Test date:		BLANK		BLANK		N/A	
Shoulder mm	0 N	**Lap** mm	0 N	**Anti** mm	0 N	**Other** mm	0 N

Raw Data must be input directly

2023 revised



Load Direction is defined in 2023 Rules T.2.6.2

Harness Attachments

Actual Load Test

If the Lap Belt and Anti-Submarine Belt share a fixed point, a strength of >30kN is required.
If not shared, select “No; Separate” (>15 kN each)

Lap Belt and Anti-Submarine Belt are mounted independently

	EQ			
	Lap belt and anti-submarine attachment:	Monocoque		EQ
F.7.10.1.d	Lap and anti-sub share attachment or insert?:	No; Separate		EQ
F.7.10.1.d	Minimum spacing, lap to anti-sub 125mm (4.92in):	130	mm	EQ
F.7.10.2.a	Minimum distance, fixture to load 125mm (4.92in):	130	mm	EQ
F.7.10.1.c	Force at failure or maximum tested >= 15kN:	16000	N	EQ

	EQ			
	Separate Anti-Sub:	Monocoque		EQ
	Same insert design as lap or anti-sub?:	Yes		EQ
F.7.10.1.c	Force at failure or maximum tested >= 15kN:	0	N	N/A

Mount shared by Lap Belt and Anti-Submarine Belt

	REJECT			
	Lap belt and anti-submarine attachment:	Monocoque		EQ
F.7.10.1.d	Lap and anti-sub share attachment or insert?:	Yes		EQ
F.7.10.1.d	Minimum spacing, lap to anti-sub 125mm (4.92in):	130	mm	N/A
F.7.10.2.a	Minimum distance, fixture to load 125mm (4.92in):	130	mm	EQ
F.7.10.1.d	Force at failure or maximum tested >= 30kN:	16000	N	REJECT

	EQ			
	Separate Anti-Sub:			N/A
	Same insert design as lap or anti-sub?:			N/A
F.7.10.1.c	Force at failure or maximum tested >= 15kN:	0	N	N/A

N/A -> Not required

Monocoque Attachments

2023 revised

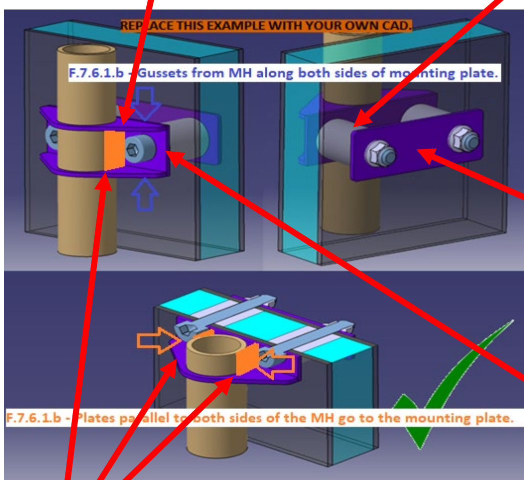
Attachment point Calculation

Attach a diagram that proves dimensions of Bracket / Insert / Backing Plate / Edge Distance

Each attachment point requires no less than two 8 mm or 5/16” minimum diameter Critical Fasteners.

The Front Hoop may be fully laminated into the monocoque if (Partially exposed for tube thickness inspection)

Gusset



Insert

No crushing of the core is permitted

Backing Plate

Steel t>2mm

Mount Plate

Input outside perimeter length & weld length correctly

Parallel Plates

Steel t>2mm

Weld Plates to both Mount plate & Main Hoop

Edge Distance

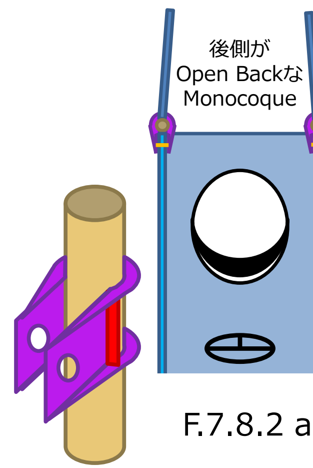
Distance from bolt center-line to nearest “free edge”

2023 added

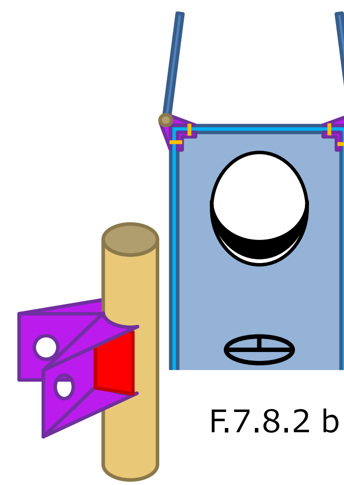
F.7.6.1

2023 added

For Semi-Monocoque ->F.7.8.2



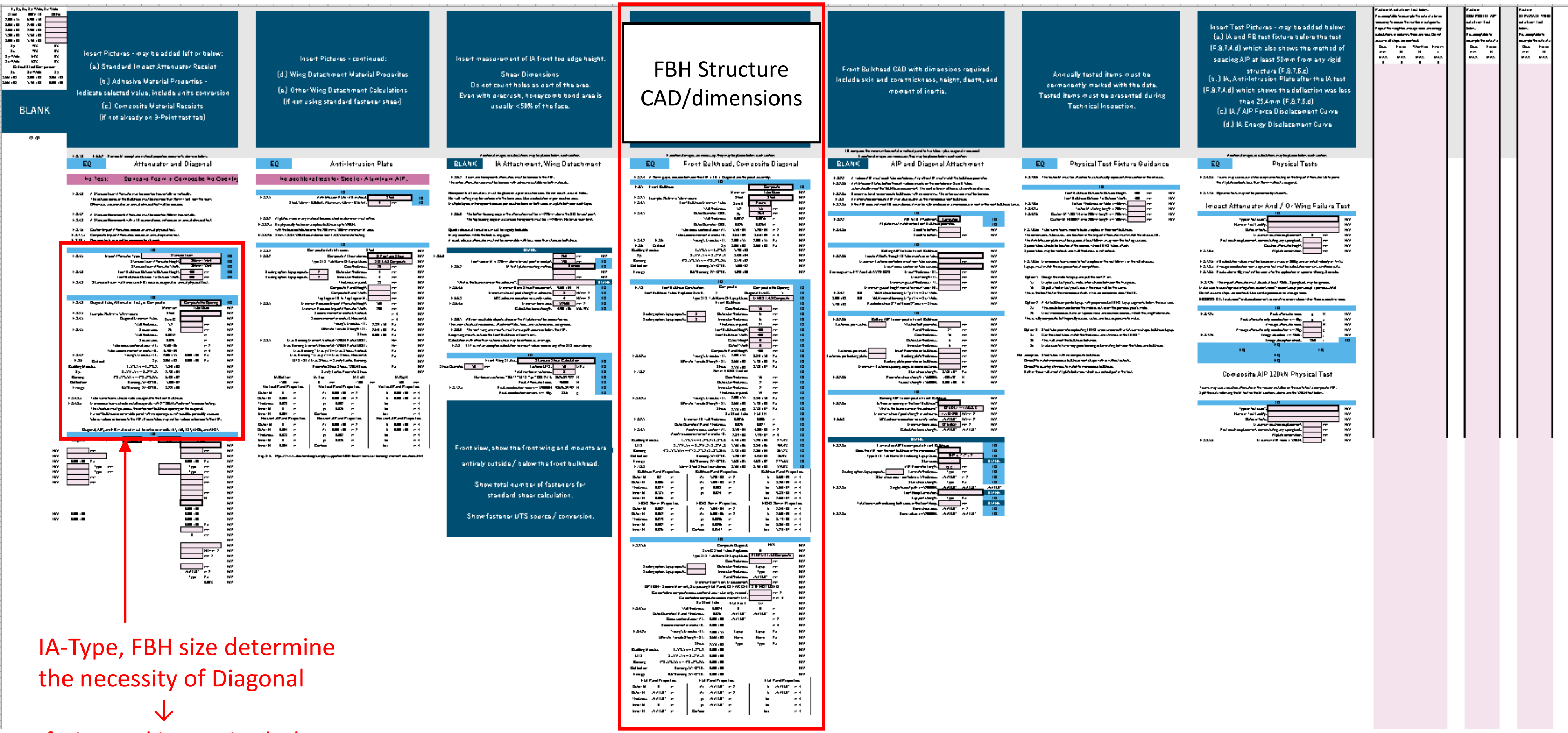
F.7.8.2 a



F.7.8.2 b

Must obey one of two.

F.8 Front Protection



IA-Type, FBH size determine
the necessity of Diagonal
↓
If Diagonal is required, choose
a conformance certification
F.8.4.3 method

Equivalency of FBH

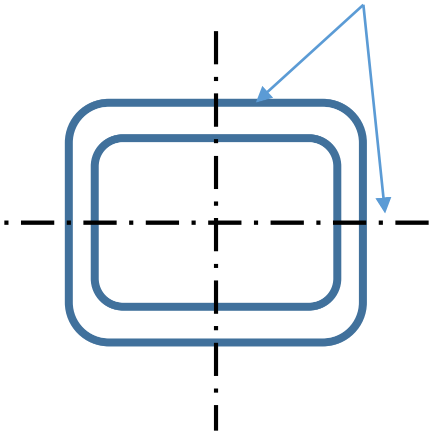
Select Structure and fill in BLANKs

Equivalency of Front Bulkhead

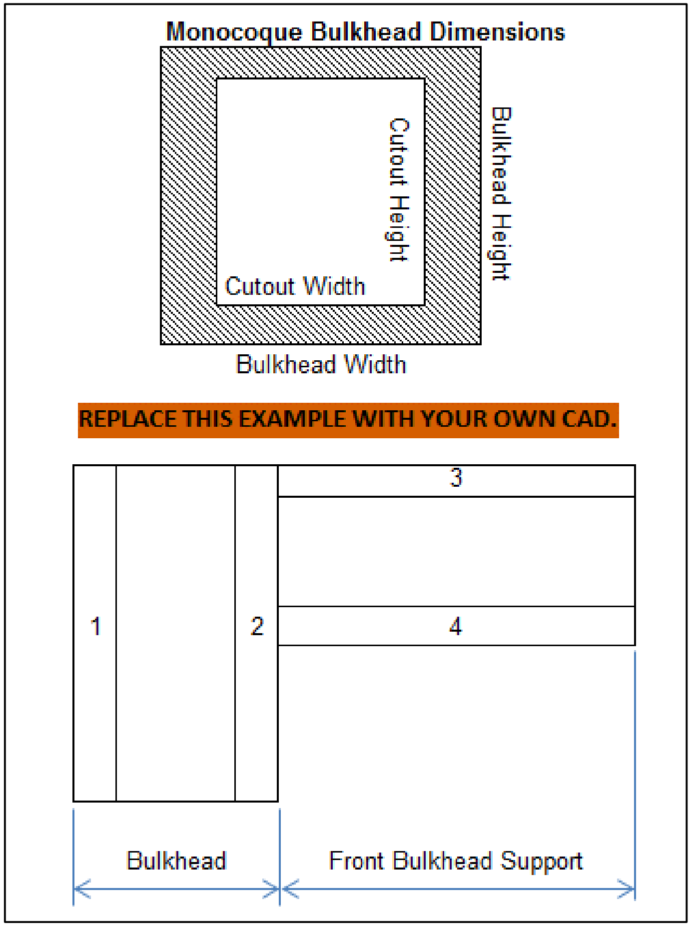
Prove equivalency to two Baseline Steel Tubes

(1) Flat panel calculation
Based on Modeled L Shape(F.7.2.1),
it will be evaluated as equivalent 2 or 3 steel tubes

Weaker cross-section is used for calculation



Since the input value of F.7 Composite Chassis is used for the FBHS part, enter them first



F.7.2.1 L shaped Model